

SECTION 31 63 16
AUGER CAST GROUT PILES**PART 1 - GENERAL****1.1 DESCRIPTION**

This section specifies excavation and concrete required for construction of auger-placed concrete piles.

1.2 DEFINITION

Auger-placed concrete pile (ACP): Pile formed by rotation of a continuous flight hollow-shaft pile augured into the ground to the indicated depth. Grout is injected through auger shaft as auger is being withdrawn in such a way as to exert removing pressure on withdrawing earth-filled auger as well as lateral pressure on soil surrounding hole.

1.3 RELATED WORK

- A. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.
- B. Concrete: Section 03 30 00, CAST-IN-PLACE CONCRETE.
- C. Subsurface investigation: Section 01 00 00, GENERAL REQUIREMENTS, Article, PHYSICAL DATA.

1.4 CONTRACT BASIS

- A. Contract price for ACP's will be based upon total length of piles shown on the Contract Documents. Length of piles will be measured as shown.
 - 1. Adjustment of contract price shall be based upon total length of piles placed, and not on length of individual piles placed. When total length of completed piles is greater or less than length shown, contract price adjustment will be made in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable.
 - 2. Contract price and time will be adjusted in accordance with Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL CONDITIONS as applicable when artificial materials that are not shown are encountered.

1.5 CONTRACTOR QUALIFICATIONS

- A. Approval by Contracting Officer is required of service of proposed Contractor and will be based upon submission by Contractor of certification that:
 - 1. Contractor has technical qualifications, experience, trained personnel and facilities to install auger placed concrete piles as specified. Approval will not be given, however, where an experience record is one of unsatisfactory performance.
 - 2. Contractor has installed ACP's on three installations similar and equivalent to this project for 5 years. Submit list of installations.

- B. Load Test: Include one load test in contract per ASTM D1143 "Static Axial Compressive Load", as located and directed by the Testing Laboratory.
- C. Place piles in accordance with the provisions of OBC 1808.

1.6 TOLERANCES

Install piling with a maximum variation of 75 mm (3 inches) of center of any pile from the location shown. Piles shall not be out of plumb more than 2 percent. (Checked by using a hand level prior to the start of drilling).

1.7 DESIGN MODIFICATIONS

- A. Install shafts with diameter at any cross-section not less than the specified dimension.
- B. Replace piles damaged, mislocated, or out of alignment beyond the maximum tolerance with new piles as directed. Contractor is responsible for paying for any corrective measures to work under separate contract such as cap modification required by Architect.
- C. Obtain Architect's approval of any increase in shaft size proposed by Contractor for convenience.

1.8 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Certification to Examination of Site and Records: Before proceeding with the Work, submit copy of certification in acceptable form signed by the Contractor, stating that careful examination has been made of the site, existing structures, and records of utility lines, test boring records, soil samples, and subsurface exploration reports by the Owner's Geotechnical Engineer, Drawings, and Specifications.
- C. Shop Drawings and Miscellaneous Submittals:
 - 1. Description of pile drilling equipment.
 - 2. Description of grout pump and pressure gage calibration reports.
 - 3. Pile Installation Recorder (PIR) calibration reports.
 - 4. Complete description of method for ACP pile installation with a pile layout plan referenced to the structural plans, including a numbering system capable of identifying each individual pile, pile sizes, including pile length and tip elevations, reinforcing steel, and waterproofing details. In addition, furnish a detailed description of construction procedures, including steel shells, if used, and auguring methods.
 - 5. Steel Reinforcement Shop Drawings: Comply with ACI 315. Furnish shop drawings prepared by a Professional Engineer licensed in the state of installation that include placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
 - a. Prior to fabrication: Indicate steel grades, sizes, bending details, protective coatings, spacing, placement and supports.

- b. Supplementary Product Literature: Furnish manufacturer's literature describing general properties of each product to be used in the Work.
 - c. Certifications: Furnish manufacturer's certified reports of mill tests for reinforcing steel and anchorage devices, including physical and chemical analysis.
- 6. Pile Installation records for all ACP's.
- D. Reports:
 - 1. Installation of each pile
 - 2. Pile location and plumbness
 - 3. Total quantity of grout placed
 - 4. Load Test
- E. Product Data: Submit copies of manufacturers' specifications for the following products, including copies of laboratory test reports and other data as may be required to show compliance with these specifications.
 - 1. Fly Ash or Ground Granulated Blast Furnace Slag: ASTM C618, Class C or F and ASTM C989, Grade 100 or 120, respectively.
 - 2. Plasticizing admixture: ASTM C1017/C1017M, Type II.
 - 3. Grout Fluidifier: ASTM C937
 - 4. Aggregate sieve analysis: ASTM C33.
 - 5. Aggregate sodium sulfate soundness tests: ASTM C88.
 - 6. Portland cement: ASTM C150, Type I, Test Piles Type III.
 - 7. Reinforcing Steel: ASTM A615/A615M, Grade 60 // ASTM A722/A722M, Type II, Thread Bar Type
- F. Certificates: Contractor's qualifications as specified: Experienced specialty piling subcontractor having a minimum of 5 years successful experience installing Work of same type required for this project, and evidence of satisfactory completion of at least ten ACP installations comparable in scope of the Work and subsurface conditions. Employ only skilled tradesmen who are thoroughly experienced with the materials and equipment to be used in the Work.
- G. Contractor's Concrete Testing: Submit 3 copies of the laboratory testing reports to the COTR, the owner's Geotechnical Consultant, and other pertinent parties.
 - 1. Submit report and certification of aggregate.
 - 2. Laboratory Test Reports: Submit for evaluation grout materials and mix designs.
- H. Pile Load Testing:
 - 1. A schedule and sequencing plan for pile testing and installation.
 - 2. Pile Installation Recorder (PIR) details.
 - 3. Pile Installation Recorder (PIR) reports.
 - 4. Pile Load Test Work Plan:

- a. At least two weeks before commencing pile load testing work, the Contractor shall submit a pile load test work plan describing the equipment, apparatus, procedures, and schedule for testing ACP's in accordance with ASTM D1143 // ASTM D3689 // ASTM D3966 and as specified herein, to verify the design pile capacity. The work plan shall also include the proposed instrumentation of the test pile indicating depth, location, and details of the pile.
- b. As part of the Pile Load Test Work Plan, submit shop drawings and other information describing the loading and test monitoring arrangement for pile load tests, including the following:
 - 1) Structural design of the test load support/reaction frame.
 - 2) Details of equipment and apparatus to be used for the monitoring load and pile movements.
 - 3) Data on testing and measuring equipment including required jack, load cell and/or gauge calibrations.
 - 4) Sample field data recording sheets or examples of automated data acquisition records proposed for recording load test data.
- I. Independent Testing and Inspection Agency: The Contractor shall retain an Independent Testing and Inspection Agency (Agency) to document, monitor, and observe load test, probe pile, test pile, and production pile work. This Agency shall submit field reports and test results required by Section 3.2 for pile load tests, pile installations, and grout testing and inspection. They shall submit a pile installation report for each pile no later than three days after the installation is complete.
- J. Welding Certificates.
- K. Qualification Data: For Installer, Land Surveyor, and Testing and Inspection Agency.
- L. Upon completion of ACP installations, the Contractor shall submit five copies of drawings indicating actual in-place pile locations. The Contractor shall pay for all surveying costs. Drawings must be submitted prior to beginning any pile cap or mat installation. One electronic copy of the drawings shall be submitted in AutoCAD DWG format on CD-ROM.
- M. Record drawings at Project closeout according to Division 01 Section "Closeout Procedures."

1.9 QUALITY CONTROL

- A. Contractor's Quality Control Responsibilities: Contractor is solely responsible for quality control of the Work.
- B. A Quality Control Program shall be submitted by the Contractor at least two weeks prior to the commencement of work. The implementation of a Contractor Quality Control Program does not relieve the Contractor from the responsibility to provide work in accordance with the Contract Documents, applicable codes, regulations, and Governing Authorities.
- C. Contractor's Independent Testing and Inspection Agency (Agency): The Contractor shall retain at his own expense, the services of a qualified Independent Testing and Inspection Agency,

licensed in the state of the project, to provide testing and inspection services during the installation of all foundation piling involved in this Work. This firm shall also provide consultation services to the Contractor if problems are encountered during the execution of the Work. The Agency shall be primarily concerned with the testing and construction methods which will result in finished foundation piling of the required quality and strength. The Agency shall also be concerned with preventing settlement and/or damage to surrounding structures, roads, utilities, embankments, etc., both within the property lines and on adjoining properties during the construction.

- D. The Agency shall be experienced in the testing and installation of ACP foundations. It shall have been involved in at least 8 different ACP projects in the last 5 years, and shall have experience in recommending, testing, and specifying ACP's for similar subsurface conditions.
- E. Survey Work: The Contractor shall engage a qualified land surveyor or professional engineer to perform surveys, layouts, and measurements for ACP's. The surveyor shall record actual measurements of each ACP's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.
- F. Contractor's Grout Mix Designer: The Contractor shall employ, at his own expense, a testing laboratory to design grout mixes, conduct tests and submit reports for the design mixes. The Grout Mix Designer shall be qualified according to ASTM C1077 and ASTM E329 to perform material evaluation tests and to design concrete mixes, as documented according to ASTM E548.
- G. Welding Standards: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1
 - 2. AWS D1.4
- H. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances and regulations of Federal, State and Municipal authorities having jurisdiction. Obtain necessary approvals from all such authorities.

1.10 QUALITY ASSURANCE

- A. The Owner shall retain the services of a Geotechnical Consultant (Consultant) to provide general observation of all pile operations and to provide technical advice to the Owner with regard to pile operations and performance.
- B. The Consultant shall have been involved in at least 8 different ACP projects in the last 5 years, and shall have experience in recommending, testing, and specifying ACP's for similar subsurface conditions.

1.11 APPLICABLE PUBLICATIONS

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.

B. American Society for Testing and Materials (ASTM):

A615/A615M-06a	Standard Specification for Deformed and Plain Carbon-Steel Bar for Concrete Reinforcement
A722/A722M-05	Standard Specification for Uncoated High-Strength Steel Bar for Prestressing Concrete
C33-03.....	Standard Specification for Concrete Aggregates
C88-05.....	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
C109/C109M-05.....	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (using 2-in. or [50 mm] Cube Specimens)
C150-05.....	Standard Specification for Portland Cement
C404-06.....	Standard Specification for Aggregates for Masonry Grout
C618-05.....	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
C937-02.....	Standard Specification for Grout Fluidifier for Preplaced- Aggregate Concrete
C942-99 (2004).....	Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory
C989-05.....	Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
C1017/C1017M-03.....	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
C1077-06.....	Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
D1143-81(1994)e1	Standard Test Method for Piles Under Static Axial Compressive Load
D3689-90(1995).....	Standard Test Method for Individual Piles Under Static Axial Tensile Load
D3966-90(1995).....	Standard Test Method for Piles Under Lateral Loads
E329-05be1	Standard Specification for Agencies Engaged in Construction Inspections and/or Testing
E548-94	Standard Guide for General Criteria Used for Evaluating Laboratory Competence

C... American Concrete Institute (ACI):

C33-03.....	Standard Specification for Concrete Aggregates
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315-99 Manual of Standard Practice for Detailing Reinforced Concrete Structures

D... American Welding Society (AWS):

D1.1 (2006) Structural Welding Code – Steel

D1.4 (2005) Structural Welding Code – Reinforcing Steel

1.12 SITE CONDITIONS

- A. Subsurface Information: Report of Geotechnical Investigation for the project prepared by the owners Geotechnical Engineer will be available to bidders for review.
- B. Mobilization and demobilization of crane and other equipment only permitted over weekends. Notify COTR prior to any planned mobilization or demobilization.
- C. Existing Utilities: Locate existing underground utilities in areas of pile installation. If utilities are to remain in service provide adequate support and protection. Refer to Drawings for additional utilities information.
- D. Protection: Protect structures and other construction from damage caused by pile operations.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Portland Cement: ASTM C150, Type I, Test piles Type III.
- B. Grout Fluidifier: ASTM C937, CRD-C619.
- C. Plasticizing admixture: ASTM C1017/C1017M, Type II
- D. Ash or Ground Granulated Blast Furnace Slag: ASTM C618, Class C or F and ASTM C989, Grade 100 or 120, respectively.
- E. Water: Fresh, clean, and potable.
- F. Aggregate: ASTM C404, Size No. 1 or Size No. 2.
- G. Reinforcing Steel: ASTM A615, Grade 60.
- H. Fine Aggregate: ASTM C33.
- I. High Strength Reinforcing Steel: ASTM A722, Type II, Thread Bar Type
- J. Except for probe pile, pile load test and test pile purposes, no pile materials shall be ordered or delivered to the job site until the required load tests have been made and are acceptable to the COTR. Materials ordered or delivered to the project site prior to verification of the assumed pile length, will be at the Contractor's risk.
- K. After pile lengths are verified by the pile load test program, deliver materials to the project site in such quantities and at such times to assure the continuity of pile augering operations to the project schedule.
- L. Clearly mark pile leads in 300 mm (1 foot) increments.

2.2 MIXES

- A. Concrete: The grout used shall consist of a mixture of portland cement, sand, fluidifier, and water so proportioned and mixed to be pumped and to fill all voids in the foundation material. Mixture shall be proportioned to provide a minimum compressive strength of 4000psi at 28 days. Minimum cement content shall be 750 lbs. per cubic yard.
- B. Mix Design: Testing Laboratory, retained by Contractor, shall design a mix to produce concrete as specified and perform tests as required. Certified test reports (duplicate) shall be submitted. Reports shall include proportions of design mix.
- C. Grout in the mixer or agitator for a period not exceeding 2-1/2 hours at grout temperatures below 70°F; and for a period not exceeding 2 hours at higher temperatures not exceeding 95°F.
- D. All materials shall be such as to produce homogeneous grout of the desired consistency. If there is a lapse in the operation, recirculate mortar through the pump.
- E. Concrete-mix design adjustments may be considered if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant. Resubmit and obtain approval from the COTR of proposed changes to concrete-mix design prior to installation.
- F. Improper Mix: Immediately notify the Concrete Testing Laboratory and the COTR if at any time during construction the accepted mix design proves to be unsatisfactory for any reason. The Contractor's Concrete Mix Designer shall modify the design, subject to the review of the COTR, until a satisfactory mix is obtained.

2.3 EQUIPMENT

- A. Augering Equipment:
 - 1. Equipment shall be of sufficient size and in good working order to smoothly turn and advance augers to the specified depth and consist of a continuous-flight, hollow-shaft auger which shall be rotated into the ground to the required pile depth as established by the pile load tests. Advance the auger at a continuous rate that prevents removal of excess soil. Stop advancement after reaching the required depth. The hole in the bottom of the auger shall be closed with a suitable plug while being advanced into the ground. The plug shall be removed by grout or with a reinforcing bar. At the start of pumping grout, raise the auger from 150 to 300 mm (6 to 12 inches) and after the grout pressure builds sufficiently, redrill the auger to the previously established tip elevation. Cement grout shall then be injected through the auger shaft as the auger is being withdrawn, in such a way as to exert removing pressure on the withdrawing earth filled auger flights as well as lateral pressure on the soil surrounding the grout-filled pile hole. Grout pumping pressures shall be measured and shall be maintained high enough at all times to offset hydrostatic and lateral earth pressures. The auger shall rotate in a positive direction and shall be withdrawn in a steady continuous motion. The equipment will be free of oil and hydraulic leaks and be equipped with required OSHA safety features.

2. The auger flighting shall be continuous from the auger head to the top of auger without gaps or other breaks. The auger flighting shall be uniform in diameter throughout its length and shall be the diameter specified for the piles less a maximum of 3 percent.
 3. The hole through which the high-strength grout is pumped during the placement of the pile shall be located at the bottom of the auger head below the bar containing the cutting teeth.
 4. Augers over 12000 mm (40 feet) in length shall contain a middle guide.
 5. The piling leads should be prevented from rotating by a stabilizing arm or by firmly placing the bottom of the leads into the ground or by some other acceptable means. Leads shall be marked at 300 mm (1 foot) intervals to facilitate measurement of auger penetration.
 6. Augers shall be bottom center discharge augers.
- B. Mixing and Pumping Equipment:
1. Only approved pumping and mixing equipment shall be used in the preparation and handling of the grout. A screen to remove over-size particles shall be placed at the pump inlet. All oil or other rust inhibitor shall be removed from mixing drums and grout pumps. All materials shall be such as to produce a homogeneous grout of the desired consistency.
 - a. The grout pump shall be a positive displacement piston type pump capable of developing displacing pressures at the pump not less than 2.5 Mpa (350 psi). The grout pump shall be provided with a pressure gauge in clear view of the equipment operator. The grout pump shall be calibrated at the beginning of the work to determine the volume of grout pumped per stroke. A positive method of counting grout pump strokes shall be provided by the Pile Contractor. Such methods may include digital or mechanical stroke counters or other acceptable methods.
- C. Pile Installation Recorder (PIR):
1. The Contractor shall provide a PIR for ACP's for use by the Agency and the Consultant during pile installation. The PIR shall be used for each piling rig. The PIR shall record appropriate information during both the augering phase and during the grouting phase of the installation to assure minimum grout volume pumped per unit depth increment, and shall print results immediately upon completion of each pile.

PART 3 - EXECUTION

3.1 GENERAL

- A. Place continuous center reinforcing through the hollow-stemmed auger prior to placement of grout. Tie top of reinforcing in place after removal of auger. Use bar spacers to center reinforcing bars.
- B. Do not install piles within 20 ft. of any concrete or masonry structure which has not attained its full design strength.
- C. Do not install piles within six pile diameters center to center of any pile less than 16 hours old.

- D. Where the pile top is within 6 inches of the surface or above the bottom of the excavation, provide metal sleeves or casing of the proper diameter for at least 18 inches in length around the pile tops. (Special conditions may require metal sleeves or additional length).
- E. Do not leave augered holes to stand overnight. Grout full length immediately after drilling.
- F. Remove obstructions that inhibit the installation of piling, (such as: portions of existing demolished buildings, boulders, existing rubble fill and cisterns) encountered within the top 10 feet of pile length, and fill resulting excavation.
- G. If a pile encounters an underground obstruction more than 10 feet below its top elevation which inhibits the pile's proper installation in the opinion of the Engineer, the pile shall be grouted and paid for as a completed pile of its actual grouted length. Provide replacement pile or piles in a location directed by the Resident Engineer.
- H. Terminate pile tips at an elevation determined for each pile by the Testing Laboratory. Actual subsurface soil conditions may require the Testing Laboratory to direct that some pile tip elevations be terminated above or below the pile tip elevation assumed for bidding.
- I. Piles shall be taken to condition of auger refusal defined as a rate of auger penetration of less than one foot per minute of drilling.

3.2 SURVEY

- A. Survey: Registered Professional Land Surveyor or Registered Civil Engineer, specified in Section 01 00 00, GENERAL REQUIREMENTS, shall establish lines and levels and stake pile locations.
- B. Before installing piles adjacent to any existing utilities, the Contractor shall notify the utility owner to ensure that protective Work will be coordinated and performed in accordance with the requirements of the utility owner. If any existing service lines, utilities and utility structures to remain in service are uncovered or encountered during these operations, protect, from damage and provide support if necessary.
- C. Should uncharted or incorrectly charted piping or other utilities be encountered during piling operations, immediately notify the COTR and the utility owner. Cooperate with the utility owner in keeping their respective services, utilities and facilities in operation.
- D. After all ACP's are in place, the Surveyor shall make a field survey of completed piles and shall submit a drawing to the COTR showing the plumbness of the piles and the actual pile locations with respect to planned pile locations.
- E. Pile Record: Submit complete and accurate record of all auger-placed piles to the COTR. Record shall indicate the pile location, diameter, length, elevation of bottom and top of pile, and the quantity of grout used in each pile. Any unusual conditions encountered during pile installation shall also be noted.
- F. Completion Certificate: The Contractor shall provide a written statement, stamped by a Professional Engineer registered in the State of the Work, verifying that the piles were installed

per the Contract Documents, and that any piles not installed per the Contract Documents were installed in such a manner that they will not have a negative impact on the proposed structure.

3.3 ALLOWABLE LOAD ON PILES

A. Probe Piles:

1. A minimum of ten probe piles shall be installed prior to the installation of the production piles in manner utilizing identical equipment, methods, and materials for all piling.
2. Probe piles shall be used by the Contractor to refine the operations of the equipment and shall not be installed at production pile locations.
3. The location of the probe piles shall be submitted to the COTR prior to their installation. If, in the opinion of COTR, the probe pile locations shown are not representative of the area, alternate locations will be provided by COTR.
4. Reaction piles for the load test pile may // may not be used as probe piles.

B. Load test piles:

1. Load tests will be performed on a minimum of 6 probe piles. The data from the load test will be used to verify pile design load.
2. Contractor shall provide all materials and testing equipment to perform all load tests in accordance with ASTM D1143. These tests will be conducted at no additional cost to the Government. No additional piles shall be installed until test reports of test piles are received and approved by COTR.
3. Additional load tests or an increase in production pile length may be required if the test pile fails the load test.
4. Load testing of piles shall be to two times the pile design load and performed in accordance with ASTM D1143, Section 5.1 Standard Loading Procedures.
5. Design of the reaction frame for an uplift reaction equal to four (4) times the pile load.
6. Pile load test shall be set up and run by the pile installer and witnessed by the Owner's Testing Laboratory at the Owner's Expense. Data received shall be evaluated by the Geotechnical Engineer to verify the theoretical design.
7. After testing to Section 5.1, reload test pile per Section 5.3, "Loading in Excess of Standard Test Load", to failure or to the limit of the reaction frame.

C. If test pile does not conform to requirements, install another test pile with a revised design at another designated location using the same testing procedures. Repeat testing procedures until satisfactory test results are achieved. These tests will be conducted at no additional cost to the Government. No additional piles shall be installed until test reports of test piles are received and approved by COTR

D. Test piles shall not be used as part of the work, unless approved by the Geotechnical Engineer. Reaction piles may be used as production piles if not damaged or otherwise displaced.

3.4 INSTALLATION

- A. The length and drilling criteria of production piles will be determined by the Owner's Geotechnical Consultant from the installation of the probe piles, reaction piles, test piles, and the pile load tests. The installation shall be performed in an orderly sequence.
- B. Advance the auger at a continuous rate that prevents removal of excess soil. Stop advancement after reaching the required depth or refusal criteria.
- C. Auger refusal is defined as a rate of auger penetration of less than 300 mm (1 foot) per minute of drilling.
- D. The hole in the bottom of the auger shall be closed while being advanced into the ground with a suitable plug. The plug shall be removed by grout pressure or with the reinforcing bar.
- E. Place continuous center reinforcing through the hollow-stemmed auger prior to placement of grout. Tie top of reinforcing in place after removal of auger. Use bar spacers to center reinforcing bars.
- F. At the start of pumping grout, raise the auger from 150 to 300 mm (6 to 12 inches) and after the grout pressure builds up sufficiently, redrill the auger to the previously established tip elevation.
- G. Maintain at least 3000 mm (10 feet) of grout on the auger flighting above the injection point during raising of the auger. Positive rotation of the auger shall be maintained throughout placement of the grout. Rate of grout injection and rate of auger withdrawal from the soil shall be coordinated as to maintain at all times the minimum grout head and a positive pressure on the gauges. The total volume of grout shall be at least 115 percent of the theoretical volume for each pile, except, after grout is flowing at the ground surface from the auger flighting, the rate of grout injection and auger withdrawal shall be coordinated so that there is a constant grout flow at the surface. If pumping of grout is interrupted for any reason, the Contractor shall reinsert the auger at least 1500 mm (5 feet) into the pile and regrout.
- H. Minimum volume of grout placed in hole shall be at least the nominal volume plus 15 percent of hole. Volume of grout per linear meter (linear foot) of pile shall be not less than volume of grout per meter (volume of grout per foot) of the load test pile. Make volume measurements in the presence of COTR.
- I. Auger hoisting equipment shall be provided that will enable the auger to be rotated while being withdrawn smoothly and steadily.
- J. The spoil that accumulates around the auger during injection of the grout shall be promptly cleared away upon completion of the installation.
- K. Provide OSHA protective caps on all projecting reinforcement.
- L. Materials shall be accurately measured by volume or by weight as they are fed to the mixer. Order of placing the materials in mixer shall be as follows: (1) water, (2) fluidifier, and (3) other solids in order of increasing particle size. Provide grout injection equipment with a pressure gage in clear view of the equipment operator. A second pressure gauge shall be located near auger rig

where it can be observed. Rate of injection and rate of auger withdrawal from soil shall be so coordinated as to maintain at all times a positive pressure on gage which will indicate existence of a removing pressure on bottom of auger flight. Magnitude of this pressure and performance of other augering and grouting procedures, such as rate of augering, rate of grout injection, and control of grout return around the auger flight, are dependent on soil conditions, and equipment capability shall be at option of Contractor, subject to approval of COTR. Equipment for pumping grout shall be positive displacement pump capable of developing a pressure at pump not less than 2.5 MPa (350 psi). Pump shall be calibrated by an approved method to verify accuracy of indicated discharge. Remove oil or other rust inhibitors from mixing drums and pumps. Auger hoisting equipment shall be capable of withdrawing auger smoothly and at a constant rate. If the auger jumps upward during withdrawal, it shall be reinserted, and rate of withdrawal decreased to prevent further jumping.

- M. Locate piles as shown unless otherwise directed by COTR. Do not place piles closer than 1050 mm (3.5 feet) center to center until grout in adjacent piles has set for 24 hours. In locations where there are no concrete slabs or other means of distributing load of the equipment placing piles, the equipment shall be kept at least 3000 mm (10 feet) away from pile location, or upper 3000 mm (10 feet) of pile shall be cased.
- N. Where pile top is near surface or above bottom of excavation, place metal sleeves of proper diameter around pile top.
- O. Cut off the tops of piles, square with pile axis and at the elevations indicated by removing fresh grout from the top of the pile or by cutting off hardened grout down to final cutoff point at any time after initial set has occurred. Where the pile cut-off is near the surface or above the bottom of the excavation, sleeves or casing of the proper diameter and at least 457 mm (18 inches) in length shall be placed around the pile tops. (Special conditions may require metal sleeves of additional length).
- P. Redrill the pile to the original depth at no additional cost to the Owner if any of the following occurs:
 - 1. The design pile reinforcement cannot be placed manually in the top of any pile following completion of grouting.
 - 2. The trap door at the bottom discharge outlet fails to open completely, effectively creating a side discharge condition.
 - 3. Loss of grout head occurs for any reason during pile installation.
 - 4. There is more than a twenty-minute delay during the grouting of any individual pile.
 - 5. There is a drop in grout level after completion of the pile, which exceeds the average for the remainder of the pile installations by more than 600 mm (2 feet).
- Q. The Contractor shall install additional piles at no additional cost for damaged, misaligned and/or mislocated piles. Contractor shall also be responsible for costs of concrete and reinforcing for

required modifications to pile caps/grade beams due to damaged piles and/or misaligned or mislocated piles.

- R. If the grout level in any completed pile drops, the pile shall be rejected and replaced.
- S. No pile shall be loaded until the grout has attained full design strength.

3.5 OBSTRUCTIONS:

- A. The advancement of the augers through naturally occurring materials such as cobbles, boulders and rock ledges, as outlined in the Geotechnical Report, is the responsibility of the Contractor. The Contractor is responsible for providing the necessary means and methods of advancing the augers through this material. The length of short piles terminated due to such foreseeable material will not be included in the total length of pile for payment at the unit price. Additional adjacent piles, as required by the COTR, will also not be included in the total length of piles for payment.
- B. In the event that unforeseen non-augerable material is encountered, such as cobbles, boulders, rock ledge, metal timbers or debris which causes the rate of penetration to be reduced to less than 300 mm (1 foot) per minute above the desired tip elevation, or causes the pile to drift from its location, then the pile shall be completed to the depth of the non-augerable material in accordance with these specifications. The length of such short piles shall be included in the total length of pile for payment at the unit price. If required by the COTR, additional adjacent piles shall be placed and the length of these additional piles shall also be included in the total length of piles for payment.

3.6 QUALITY CONTROL AND ASSURANCE:

- A. The Contractor shall retain the services of a qualified Independent Testing and Inspection Agency (Agency), licensed in the state of the project, to provide Quality Control through testing and inspection services during the installation of all foundation piling involved in this Work.
- B. The Owner shall employ a Geotechnical Consultant (Consultant) to provide Quality Assurance through general observation and consultation of all pile operations.
- C. The Contractor and their Agency shall cooperate with the Consultant and the COTR in the performance of the Work. The presence of Consultant shall in no way relieve the Contractor of his obligation to perform the pile installation in accordance with the Contract Documents and these Specifications.
- D. Grout Mix: The grout mix shall be tested by making a minimum of six, 50 mm (2 inches) cubes for each day during which piles are placed. A set of six cubes shall consist of two cubes to be tested at seven days, and two cubes to be tested at 28 days and two cubes held in reserve. Test cubes shall be cured and tested in accordance with ASTM C109/C109M. Cube specimens may be restrained from expansion as described in ASTM C942.
- E. Pile Acceptance: The Agency shall immediately notify the Consultant and the COTR if any pile is not in conformance with these Specifications. The volume of grout placed in each pile shall be a

minimum of 115% of theoretical volume of the pile. The amount of grout placed in each 1500 mm (5 feet) increments of the pile shall be checked continuously during installation. The cost of removing and replacing Auger Cast Piles, which are not in conformance, shall be borne by the Pile Contractor.

- F. Reports: The Agency shall maintain an installation record of each pile. The record shall note the project name and number, name of Contractors, pile location, design pile capacity, pile tip elevation, pile top elevation, depth of auger advancement, (total and continuous) quantity of grout placed, reinforcing steel placement, and any unusual occurrences during the pile installation. The grout quantity shall be determined by recording grout pump displacement or by other acceptable means. The Consultant shall also maintain a daily report, which summarizes all work performed by the Contractor.

3.7 CORRECTIONS OF DEFICIENCIES:

- A. The contractor shall notify the COTR in writing, of the failure of a pile to meet any requirement of the Section. Such written notification shall include all information required for the evaluation of remedial measures, including all information required for redesign.
- B. Based on the survey provided, if a pile fails to comply with the location or tolerance requirements of 1.6, or the design load requirements noted on the Contract Documents, the COTR will calculate the load capacity requirements of that pile or, if in a pile group, each pile in that pile group, based on the actual, "as-driven" locations and inclinations. If the calculation indicates that the loading on that pile or, if in a pile group, on any pile in that pile group, exceeds 110 percent of the design load, then the Contractor shall perform such remedial work as the COTR in his sole discretion may require including but not limited to furnishing and installing additional piles at locations approved by the COTR and modifying concrete or reinforcement steel. These corrective measures shall be performed solely at the Contractor's expense.
- C. If a pile fails to comply with the requirements of this Section and the COTR of record determines that modification to concrete or reinforcement steel, or the driving of additional piles is necessary, the Engineer of record will perform all required reanalysis, redesign and detailing. All reanalysis, redesign and redetailing costs will be the responsibility of the contractor and reimbursed as a change to the contract.
- D. The Contractor, at his option and at any time that he determines that a pile will not satisfy the requirements of this Section for a reason other than encountering an unforeseen underground obstruction, may, subject to the provisions of this specification, abandon such pile and replace it with a new pile or piles rather than await direction or approval from the COTR. However, the Contractor, in exercising this option, assumes the risk that such replacement pile or piles will be acceptable to the Engineer.
- E. Abandoned piles shall be cut off 300 mm (1 foot) below the elevation of the bottom of the pile cap or mat as shown on the Contract Drawings and will not be paid for.

3.8 CLEAN UP:

- A. All debris from excavation of objectionable material, removal of obstructions, and any material not to remain as part of the construction are to be removed and disposed of by the subcontractor in a legal manner at no additional cost to the Owner.
- B. The site shall be cleaned at frequent intervals and no material shall be stored on the site in a manner, which would obstruct the easy access of equipment and personnel.

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